Earth's Structure and Processes

8-3 The student will demonstrate an understanding of materials that determine the structure of Earth and the processes that have altered this structure. (Earth Science)

8-3.2 Explain how scientists use seismic waves – primary, secondary, and surface waves – and Earth's magnetic fields to determine the internal structure of Earth.
Taxonomy level: 2.7-B Understand Conceptual Knowledge

Previous/future knowledge: Seismic waves and Earth's magnetic fields are new material for this grade. Earth's internal structure (8-3.1) was also new content. The understanding of waves is also part of the 8th grade indicator 8-6.1-3 and can enhance the understanding of seismic waves in this context.

It is essential for students to know that earthquakes produce three types of waves with different behaviors as they travel through materials.

Primary (P) waves

- Move out from the earthquake focus, the point where the energy is released
- Travel the fastest of the three waves
- Move through solid and liquid layers of Earth
- Push and pull rock creating a back-and-forth motion in the direction the wave is moving (*longitudinal wave*)

Secondary (S) waves

- Move out from the earthquake focus
- Move slower than primary waves
- Can only move through solid rock
- Move at right angles to primary waves causing rocks to move up and down and side to side (*transverse wave*)

Surface waves

- Form when P and S waves reach the surface
- Can cause the ground to shake making rock sway from side to side and roll like an ocean wave

Scientists use the principle that the speed and direction of a seismic wave depends on the material it travels through. Because of the behavior of these different waves, scientists have indirect evidence for the solid inner core and liquid outer core of Earth; because earthquake waves travel faster through the mantle than through the crust, scientists know that the mantle is denser than the crust.

It is also essential for students to know that the movement of materials in the outer core of Earth is inferred to be the cause of Earth's magnetic field. A compass needle will align with the lines of force of Earth's magnetic field. Iron and nickel are metals that easily magnetize, and are inferred to be the metals in Earth's core.

It is not essential for students to know how to measure an earthquake with the Richter or Mercalli scale. The study of Earth's magnetosphere is also not necessary here.

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Assessment Guidelines:

The objective of this indicator is to *explain* how scientists use data from seismic waves and Earth's magnetic field; therefore, the primary focus of assessment should be to construct a cause-and-effect model of what data from these sources allow scientists to determine about Earth's internal structure. However, appropriate assessments should also require students to *summarize* how seismic waves and magnetic field data can be used to infer what the inside of Earth looks like; *interpret* a diagram of seismic wave properties; *compare* the waves as to movement or effect on Earth material; *identify* a layer of Earth's interior based on evidence presented; or *recall* how a compass will behave within the Earth's magnetic field.